

Search Plan and Results

Question

[What are the health effects related to consumption of chocolate? \(DGAC 2010\)](#)

Date Searched

10/13/09 and 12/18/09

Inclusion Criteria

Q5.3: What are the health benefits related to consumption of fats from specific foods (Chocolate) and health outcomes?

Health Outcomes:

- CVD/CHD risks
- Blood Pressure
- Endothelial function:flow mediated dilatation
- Blood lipids - LDL-C, HDL-C; nonHDL-C
- insulin sensitivity; glucose tolerance, T2D risks

Subjects/Population

Age: 2 years to Adults

Setting: Any, except ICU, Burn Unit in patient or Emergency Care, US and International
Non-hospitalized

Health Status:

- Healthy
- Dyslipidemia, Hyperlipidemia* or Hypercholesterolemia, CHD, CVD, Type 2 Diabetes

*According to ATP III (2004), hyperlipidemia is defined as a TC greater than 200 and/or LDL-C greater than 130 without CVD; LDL-C greater than 100 with CVD; and LDL-C greater than 70 for patients with a CHD event, stroke, TIA, peripheral vascular disease AND ONE OF THE FOLLOWING:1) acute coronary syndrome, 2) type 2 diabetes mellitus, 3) metabolic syndrome, 4) a SINGLE POORLY CONTROLLED risk factor, 5) 3 risk factors irrespective of how well controlled.

Note: in ATP III, diabetes is regarded as a CHD risk equivalent.

Nutrition Related Problem/Condition:

Cardiac Events: MI, arrhythmia, angioplasty, stent, death, weight gain, incidence of type 2 diabetes, gall bladder disease

Study design preferences:

- Randomized Controlled Trials
- Meta-analysis and Systematic reviews
- Prospective Cohort Studies

Feeding period must be greater than 4 weeks.

Size of study groups:

- Sample size must equal 10 subjects for each study group. For example, this would include 10 subjects in the intervention group and 10 subjects in the control or comparison group.

Study dropout rate: Less than 20%; preference for smaller dropout rates

Year Range: January 1999 to November 2009:

Authorship:

- If an author is included on more than one Review Article or primary research article that is similar in content, the most recent review or article will be accepted and earlier versions will be rejected.
- If an author is included on more than one Review Article or primary research article and the content is different, then both reviews may be accepted.

Languages: Limited to articles in English

Other: Article must be published in peer-reviewed journal

Exclusion Criteria

Subjects/Population

Age:

Setting: ICU, Burn Unit, Emergency Care, hospitalized

Health Status:

- Diagnosed with disease

Nutrition Related Problem/Condition: Cardiac Events: stroke

Size of study groups: Sample sizes < 10

Study Designs:

- Cross Sectional Studies
- Case Control Studies
- Feeding periods
- Experimental fat must be from natural sources

Study Dropout rate: Dropout rate in a study is 20% or greater

Year Range: Prior to December 1998

Authorship: Studies by same author similar in content

Languages: Articles not in English

Other: Animal studies; Abstracts or presentations

Search Terms: Search Vocabulary

"Cacao"[Mesh] AND (chocolate OR cocoa OR "Flavonoids"[Mesh])

("Cacao" OR chocolate OR cocoa) AND (coronary OR cardiovascular OR heart OR diabetes OR "blood pressure" OR hypertension OR "weight gain" OR "insulin sensitivity" OR cholesterol OR "glucose tolerance" OR hypercholesterolemia OR Dyslipidemia OR hyperlipidemia OR markers of inflammation)

Electronic Databases

Total hits from all electronic database searches: 190

Total articles identified to review from electronic databases: 47

Articles Identified Via Handsearch or Other Means

Summary of Articles Identified to Review

Number of Primary Articles Identified: 10

Number of Review Articles Identified: 3

Total Number of Articles Identified: 13

Number of Articles Reviewed but Excluded: 34

List of Articles Included for Evidence Analysis

Systematic Reviews /Meta-analysis:

Ding EL, Hutfless SM, Ding X, Girotra S. [Chocolate and prevention of cardiovascular disease: a systematic review.](#) Nutr Metab (Lond). 2006 Jan 3; 3:2. PMID: 16390538

Desch S, Schmidt J, Kobler D, Sonnabend M, Eitel I, Sareban M, Rahimi K, Schuler G, Thiele H. [Effect of cocoa products on blood pressure: systematic review and meta-analysis.](#) Am J Hypertens. 2010 Jan;23(1):97-103. Epub 2009 Nov 12. PMID: 19910929

Hooper L, Kroon PA, Rimm EB, Cohn JS, Harvey I, Le Cornu KA, Ryder JJ, Hall WL, Cassidy A. [Flavonoids, flavonoid-rich foods, and cardiovascular risk: a meta-analysis of randomized controlled trials.](#) Am J Clin Nutr. 2008 Jul;88(1):38-50. PMID: 18614722

Primary Articles:

Allen RR, Carson L, Kwik-Uribe C, Evans EM, Erdman JW Jr. [Daily consumption of a dark chocolate containing flavanols and added sterol esters affects cardiovascular risk factors in a normotensive population with elevated cholesterol.](#) J Nutr. 2008 Apr;138(4):725-31. PMID: 18356327

Baba S, Osakabe N, Kato Y, Natsume M, Yasuda A, Kido T, Fukuda K, Muto Y, Kondo K. [Continuous intake of polyphenolic compounds containing cocoa powder reduces LDL oxidative susceptibility and has beneficial effects on plasma HDL-cholesterol concentrations in humans.](#) Am J Clin Nutr. 2007 Mar;85(3):709-17. PMID: 17344491

Buijsse B, Feskens EJ, Kok FJ, Kromhout D. [Cocoa intake, blood pressure, and cardiovascular mortality: the Zutphen Elderly Study.](#) Arch Intern Med. 2006 Feb 27;166(4):411-7. PMID: 16505260

Crews WD Jr, Harrison DW, Wright JW. [A double-blind, placebo-controlled, randomized trial of the effects of dark chocolate and cocoa on variables associated with neuropsychological functioning and cardiovascular health: clinical findings from a sample of healthy, cognitively intact older adults.](#) Am J Clin Nutr. 2008 Apr;87(4):872-80. PMID: 18400709.

Davidson K, Coates AM, Buckley JD, Howe PR. [Effect of cocoa flavanols and exercise on cardiometabolic risk factors in overweight and obese subjects.](#) Int J Obes (Lond). 2008 Aug;32(8):1289-96. Epub 2008 May 27. PMID: 18504447.

Farouque HM, Leung M, Hope SA, Baldi M, Schechter C, Cameron JD, Meredith IT. [Acute and chronic effects of flavanol-rich cocoa on vascular function in subjects with coronary artery disease: a randomized double-blind placebo-controlled study.](#) Clin Sci (Lond). 2006 Jul;111(1):71-80. PMID: 16551272

Janszky I, Mukamal KJ, Ljung R, Ahnve S, Ahlbom A, Hallqvist J. [Chocolate consumption and mortality following a first acute myocardial infarction: the Stockholm Heart Epidemiology Program.](#) J Intern Med. 2009 Sep;266(3):248-57. PMID: 19711504

Kurlansky, SB, Stote, KS. [Cardioprotective effects of chocolate and almond consumption in healthy women.](#) Nutr Research 2006;26:509-516.(No PubMed ID)

Monagas M, Khan N, Andres-Lacueva C, Casas R, Urpí-Sardà M, Llorach R, Lamuela-Raventós RM, Estruch R. [Effect of cocoa powder on the modulation of inflammatory biomarkers in patients at high risk of cardiovascular disease.](#) Am J Clin Nutr. 2009 Sep 23. [Epub ahead of print] PMID: 19776136.

Taubert D, Roesen R, Lehmann C, Jung N, Schomig E. [Effects of low habitual cocoa intake on blood pressure and bioactive nitric oxide: a](#)

List of Excluded Articles with Reason

Articles	Reason for Exclusion
Balzer J, Rassaf T, Heiss C, Kleinbongard P, Lauer T, Merx M, et al. Sustained benefits in vascular function through flavanol-containing cocoa in medicated diabetic patients a double-masked, randomized, controlled trial . J Am Coll Cardiol. 2008;51(22):2141-9. PMID: 18510961.	Single-dose ingestion of cocoa, with increasing concentrations of flavanols
Bordeaux B, Yanek LR, Moy TF, White LW, Becker LC, Faraday N, Becker DM. Casual chocolate consumption and inhibition of platelet function . Prev Cardiol. 2007 Fall;10(4):175-80. PMID: 17917513	Cross sectional Study
Cienfuegos-Jovellanos E, Quiñones Mdel M, Muguerza B, Moulay L, Miguel M, Aleixandre A. Antihypertensive effect of a polyphenol-rich cocoa powder industrially processed to preserve the original flavonoids of the cocoa beans . J Agric Food Chem. 2009 Jul 22;57(14):6156-62. PMID: 19537788	Intervention was a single oral dose
Corder R. Red wine, chocolate and vascular health: developing the evidence base . Heart. 2008 Jul;94(7):821-3. No abstract available. PMID: 18552215	Narrative review
Corti R, Flammer AJ, Hollenberg NK, Lusher TF. Cocoa and cardiovascular health . Circulation. 2009 Mar 17;119(10):1433-41. PMID: 19289648.	Narrative review. Used for references
di Giuseppe R, Di Castelnuovo A, Centritto F, Zito F, De Curtis A, Costanzo S, Vohnout B, Sieri S, Krogh V, Donati MB, de Gaetano G, Iacoviello L. Regular consumption of dark chocolate is associated with low serum concentrations of C-reactive protein in a healthy Italian population . J Nutr. 2008 Oct;138(10):1939-45. PMID: 18806104.	Only measured CRP
Faridi Z, Njike VY, Dutta S, Ali A, Katz DL. Acute dark chocolate and cocoa ingestion and endothelial function: a randomized controlled crossover trial . Am J Clin Nutr. 2008 Jul;88(1):58-63. PMID: 18614724	Intervention was a single oral dose
Fisher ND, Hughes M, Gerhard-Herman M, Hollenberg NK. Flavanol-rich cocoa induces nitric-oxide-dependent vasodilation in healthy humans . J Hypertens. 2003 Dec;21(12):2281-6. PMID: 14654748.	Four day intervention +infusion
Flammer AJ, Hermann F, Sudano I, Spieker L, Hermann M, Cooper KA, Serafini M, Lüscher TF, Ruschitzka F, Noll G, Corti R. Dark chocolate improves coronary vasomotion and reduces platelet reactivity . Circulation. 2007 Nov 20;116(21):2376-82. Epub 2007 Nov 5. PMID: 17984375	Intervention was a single oral dose -2 hrs. Variable studied not of included
Galleano M, Oteiza PI, Fraga CG. Cocoa, chocolate and cardiovascular disease . J Cardiovasc Pharmacol. 2009 Aug 20. [Epub ahead of print] PMID: 19701098	Narrative review
Giannandrea F. Correlation analysis of cocoa consumption data with worldwide incidence rates of testicular cancer and hypospadias . Int J Environ Res Public Health. 2009 Feb;6(2):568-78. Epub 2009 Feb 5. PMID: 19440400	Epi study, correlation analyses
Heiss C, Kleinbongard P, Dejam A, Perré S, Schroeter H, Sies H, Kelm M. Acute consumption of flavanol-rich cocoa and the reversal of endothelial dysfunction in smokers . J Am Coll Cardiol. 2005 Oct 4;46(7):1276-83. PMID: 16198843.	2 day intervention; n =4 in one arm
Hirano R, Osakabe N, Iwamoto A, Matsumoto A, Natsume M, Takizawa T, Igarashi O, Itakura H, Kondo K. Antioxidant effects of polyphenols in chocolate on low-density lipoprotein both in vitro and ex vivo . J Nutr Sci Vitaminol (Tokyo). 2000 Aug;46(4):199-204. PMID: 11185658.	Acute study; 2h and 4 h after ingestion; n=3 males
Hodgson JM, Devine A, Burke V, Dick IM, Prince RL. Chocolate consumption and bone density in older women . Am J Clin Nutr. 2008 Jan;87(1):175-80. PMID: 18175753.	Cross sectional study
Hooper L, Kroon PA, Rimm EB, Cohn JS, Harvey I, Le Cornu KA, Ryder JJ, Hall WL, Cassidy A. Flavonoids, flavonoid-rich foods, and cardiovascular risk: a meta-analysis of randomized controlled trials . Am J Clin Nutr. 2008 Jul;88(1):38-50. PMID: 18614722.	Studying flavonoids in acute studies and not chocolate
Jourdain C, Tenca G, Deguercy A, Troplin P, Poelman D. In-vitro effects of polyphenols from cocoa and beta-sitosterol on the growth of human prostate cancer and normal cells . Eur J Cancer Prev. 2006 Aug;15(4):353-61. PMID: 16835506.	In vitro study
K Hollenberg N Vascular action of cocoa flavanols in humans: the roots of the story . J Cardiovasc Pharmacol. 2006;47 Suppl 2:S99-102; discussion S119-21. PMID: 16794463.	Narrative review

Kenny TP, Shu SA, Moritoki Y, Keen CL, Gershwin ME. Cocoa flavanols and procyanidins can modulate the lipopolysaccharide activation of polymorphonuclear cells in vitro . J Med Food. 2009 Feb;12(1):1-7. PMID: 19298189.	In vitro study
Mathur S, Devaraj S, Grundy SM, Jialal I. Cocoa products decrease low density lipoprotein oxidative susceptibility but do not affect biomarkers of inflammation in humans . J Nutr. 2002 Dec;132(12):3663-7. PMID: 12468604	Included in systematic review by Ding et al.
Matsumoto M, Tsuji M, Okuda J, Sasaki H, Nakano K, Osawa K, Shimura S, Ooshima T. Inhibitory effects of cacao bean husk extract on plaque formation in vitro and in vivo . Eur J Oral Sci. 2004 Jun;112(3):249-52. PMID: 15154923 .	Intervention cocoa bean husk extract
McCarty MF, Barroso-Aranda J, Contreras F. Potential complementarity of high-flavanol cocoa powder and spirulina for health protection . Med Hypotheses. 2009 Jul 2. [Epub ahead of print] PMID: 19577379	Narrative review
McCullough ML, Chevaux K, Jackson L, Preston M, Martinez G, Schmitz HH, Coletti C, Campos H, Hollenberg NK. Hypertension, the Kuna, and the epidemiology of flavanols . J Cardiovasc Pharmacol. 2006;47 Suppl 2:S103-9; discussion 119-21. PMID: 16794446.	Variables measured not included
Nahas R. Complementary and alternative medicine approaches to blood pressure reduction: An evidence-based review . Can Fam Physician. 2008 Nov;54(11):1529-33. Review. No abstract available. PMID: 19005120.	Review, used as a source for references
Oba S, Nagata C, Nakamura K, Fujii K, Kawachi T, Takatsuka N, Shimizu H. Consumption of coffee, green tea, oolong tea, black tea, chocolate snacks and the caffeine content in relation to risk of diabetes in Japanese men and women . Br J Nutr. 2009 Oct 12;1-7. [Epub ahead of print] PMID: 19818197.	Study based on effect of caffeine
Osakabe N, Baba S, Yasuda A, Iwamoto T, Kamiyama M, Takizawa T, Itakura H, Kondo K. Daily cocoa intake reduces the susceptibility of low-density lipoprotein to oxidation as demonstrated in healthy human volunteers . Free Radic Res. 2001 Jan;34(1):93-9. PMID: 11235000.	N=9 intervention group; n=6 control group; 2 week
Patanè S, Marte F, La Rosa FC, Rocca RL. Atrial fibrillation associated with chocolate intake abuse and chronic salbutamol inhalation abuse . Int J Cardiol. 2009 Jan 24. [Epub ahead of print] PMID: 19171401.	Case control study; n=1
Patel AK, Rogers JT, Huang X. Flavanols, mild cognitive impairment, and Alzheimer's dementia . Int J Clin Exp Med. 2008;1(2):181-91. Epub 2008 Apr 15. PMID: 19079672.	Narrative review
Polagruoto JA, Wang-Polagruoto JF, Braun MM, Lee L, Kwik-Uribe C, Keen CL. Cocoa flavanol-enriched snack bars containing phytosterols effectively lower total and low-density lipoprotein cholesterol levels . J Am Diet Assoc. 2006 Nov;106(11):1804-13. PMID: 17081832.	Study effect of phytosterols
Rein D, Paglieroni TG, Wun T, Pearson DA, Schmitz HH, Gosselin R, Keen CL. Cocoa inhibits platelet activation and function . Am J Clin Nutr. 2000 Jul;72(1):30-5. PMID: 10871557	Acute ingestion; single dose, 2h and 6h analyses
Ried K, Frank OR, Stocks NP. Dark chocolate or tomato extract for prehypertension: a randomised controlled trial . BMC Complement Altern Med. 2009 Jul 8;9:22. PMID: 19583878 .	In vitro study
Schnorr O, Brossette T, Momma TY, Kleinbongard P, Keen CL, Schroeter H, Sies H. Cocoa flavanols lower vascular arginase activity in human endothelial cells in vitro and in erythrocytes in vivo . Arch Biochem Biophys. 2008 Aug 15;476(2):211-5. Epub 2008 Mar 6. PMID: 18348861.	In vitro study
Schramm DD, Wang JF, Holt RR, Ensunsa JL, Gonsalves JL, Lazarus SA, Schmitz HH, German JB, Keen CL. Chocolate procyanidins decrease the leukotriene-prostacyclin ratio in humans and human aortic endothelial cells . Am J Clin Nutr. 2001 Jan;73(1):36-40. PMID: 11124747.	In vitro study
Strandberg TE, Strandberg AY, Pitkälä K, Salomaa VV, Tilvis RS, Miettinen TA. Chocolate, well-being and health among elderly men . Eur J Clin Nutr. 2008 Feb;62(2):247-53. Epub 2007 Feb 28. PMID: 17327862.	Does not address health outcomes of the question
Wan Y, Vinson JA, Etherton TD, Proch J, Lazarus SA, Kris-Etherton PM. Effects of cocoa powder and dark chocolate on LDL oxidative susceptibility and prostaglandin concentrations in humans . Am J Clin Nutr. 2001 Nov;74(5):596-602. PMID: 11684527	Included in systematic review by Ding et al

